Division 1:
Prehospital
Environment

Section 8: Assessment and Management of Shock

TOPIC	CONTENT OUTLINE

Introduction

The student must have successfully completed the following sections prior to participating in this section:

Section 1. Roles and Responsibilities

Section 2. EMS Systems

Section 3. Medical/Legal Considerations

Section 4. Medical Terminology

Section 5. EMS Communications

Section 6. General Patient Assessment and Initial Management

Section 7. Airway Management and Ventilation

The understanding and management of shock or cellular oxygenation is the essence of all patient care. If the treatment is done inadequately or too late the patient will die immediately from cardiac failure or in a few days to a few weeks from other organ failure such as lung, kidney or liver, or may survive but without brain function.

The problem is not mystic either in etiology, pathophysiology or management, but the EMT must understand it and make this understanding work for him, not against him. For example: At times the best treatment may be airway, fluids, Pneumatic antishock garment (PASG), and rapid transportation to a hospital. At other times there may be intensive on scene care.

Objectives

At the completion of this section, the student will be able to:

1.8.1 Define shock based on aerobic and anaerobic metabolism.

1.8.2 Discuss the prevention of anaerobic metabolism.

1.8.3 Discuss red blood cell oxygenation in the lungs based on alveolar O_2 levels and transportation across the alveolar capillary wall.

1.8.4 Discuss tissue oxygenation based on tissue perfusion and release of oxygen.

1.8.5 Discuss the role played by respiration, inadequate ventilation in the management of shock.

1.8.6 Describe perfusion and the mechanisms of improvement of cardiac output based on the strength and rate of contractions.

1.8.7 Discuss the fluid component of the cardiovascular system and the relationship between the volume of the fluid and the size of the container.

1.8.8 Discuss systemic vascular resistance, the relationship of diastolic pressure to the SVR and the effect of diastolic pressure on coronary circulation.

1.8.9 Discuss the container size in its relationship to the fluid volume and the effect on blood returning to the heart.

1.8.10 Discuss body fluids based on total body water, intracellular fluid, and extracellular fluid.

1.8.11 Identify the significant anions and cations in the body.

1.8.12 Describe the role of protein.

1.8.13 Discuss osmosis. Define semi-permeable membranes, and discuss their function.

1.8.14 Define isotonic fluids, hypotonic fluids, and hypertonic fluids

1.8.15 Define and discuss diffusion.

1.8.16 Define active transport.

1.8.17 Describe the mechanisms of concentration of electrolytes.

1.8.18 Define acid-base balance.

1.8.19 Discuss acid-base balance based on hydrogenion concentration, pH, buffer systems.

Define and discuss the following:

a. Respiratory acidosis.

b. Respiratory alkalosis.

c. Metabolic acidosis.

d. Metabolic alkalosis.

1.8.21 Describe the mechanism of the body response to perfusion change.

1.8.22 Identify the role of the baroreceptor.

1.8.23 Describe how the actions of the baroreceptor affect blood pressure and perfusion.

1.8.24 Describe compensated shock.

1.8.25 Describe uncompensated shock, both cardiac and peripheral effects.

1.8.26 Discuss the assessment of the patient's perfusion status, based on physical observations within the primary survey, including pulse, skin, temperature, capillary refill.

Discuss the relationship of the neurological exam to assessment of hypoperfusion and oxygenation.

8.28 Describe the information provided by the following in physical examination: pulse, blood pressure, diastolic pressure, systolic pressure, skin color, appearance, temperature, and respiration.

8.29 Discuss management of a shocky patient. Include red cell oxygenation, tissue ischemic sensitivity, IV fluids, the pneumatic antishock garment.

1.8.30 Describe the beneficial and detrimental effects of the pneumatic antishock garment.

Describe the indication and contraindications for the pneumatic antishock garment.

1.8.32 Discuss fluid replacement, the types of fluid that are available, the benefits and detrimental effects of each.

1.8.33 Discuss how fluid replacement is monitored and controlled.

1.8.34 Discuss the routes of fluid replacement and the advantages and disadvantages of each.

S1.8.35 Demonstrate in order of priority the steps of shock resuscitation.

S1.8.36 Demonstrate the use of the pneumatic antishock garment (PASG)

S1.8.37 Demonstrate the proper technique to insert an intravenous catheter.

(S) Indicates Skill Objective

TOPIC	CONTENT OUTLINE
Definition	A. Parameters of measurement are not an adequate definition 1. Blood pressure, pulse or respiration B. Inadequate cellular oxygenation produces anaerobic metabolism Anaerobic metabolism equals shock 1. Aerobic metabolism is dependent upon a. RBC oxygenation i. Alveolar 0_2 levels (a) Airway (b) Ventilation (c) $Fi0_2$ b. Transport of RBC, transport across alveolar/capillary wall. This is dependent on no edema to reduce passage, presence of RBC in capillary and ventilation of the alveolus 2. Tissue oxygenation a. Adequate number of RBC b. Adequate tissue perfusion c. Adequate release of oxygen
Physiology of Perfusion	A. Heart output or effectiveness is dependent on three components 1. Strength of contractions 2. Rate of contractions 3. Volume of blood B. Fluid 1. Fluid volume 2. Systemic vascular resistance (SVR) is another name for peripheral resistance. The diastolic pressure is an estimate of SVR. The amount of back pressure during diastole also determines the flow of blood through the coronary circulation C. Container 1. Fluid volume and container size a. 5 liter container and 5 liters of fluid = full container b. 5 liter container and 3 liters of fluid = partially full container c. 3 liter container and 3 liters of fluid = full container d. 7 liter container and 5 liters of fluid = partially full container D. Cellular Physiology 1. Body fluids a. Total body water 60% adult weight divided into two components b. Intracellular fluid inside the cell membrane 40% body weight c. Extracellular fluid outside the cell 20% body weight 2. Electrolytes ions a. Cations sodium (Na+) Potassium (K+) Calcium (Ca++) b. Anions cloride (Cl−) bicarbonate (HCO_3−) 3. Protein a. Albumin b. Plasma c. Lymph

INSTRUCTOR'S NOTES

Prevention of anaerobic

Pump.

Volume/size of container.

Standard normovolemic adult.

Hypovolemic adult. Blood loss from acute hemorrhage or severe dehydration.

TBW.

ICF. water & electrolytes.

ECF water & electrolytes.

Salt.

Positive charge.

Negative charge.

d. Other

4. Osmosis
   a. Semipermeable membrane
      i. Water, freely interchangeable on both sides
      ii. Electrolytes cannot actively cross to other side.
      iii. Water crosses to equalize the concentration—higher concentration pulls fluid from lower concentrations
   b. Isotonic fluids. Osmotic pressure is equal to normal body fluid
   c. Hypotonic. Osmotic pressure less than that of normal body fluids
   d. Hypertonic. Osmotic pressure greater than that of normal body fluids
5. Diffusion. Solute molecules can cross membranes but at a slower rate than water
6. Active transport
   a. Larger molecules can be moved across membranes
   b. Molecules can move toward higher concentrations
   c. Energy is required
   d. Faster than diffusion
7. Concentration of electrolytes
   a. Water follows sodium
   b. Potassium (K+) is the chief intracellular ion
   c. Sodium (Na+) is the chief extracellular ion
   d. Changes in ion concentrations affect skeletal and cardiac muscle cells ability to function (K+, Ca+, Mg+)
8. Acid-base balance
   a. Definition: concentration of hydrogen ions in body fluids [H]+
   b. pH expression of [H+]
      i. pH = 7.35 to 7.45 ph below 7.35 is acidosis (excess [H+])
      ii. pH above 7.45 is alkalosis (low [H+])
   c. Buffer system offsets minor changes in pH
      i. Carbonate buffer system can absorb 20/1 H+ without a noticeable change in pH
      ii. Change is as follows:
      $CO_2 + H_2O -> H_2CO_3 -> H+ = HCO_3$—this process can proceed in either direction $H + HCO_3$—
      $>H_2CO_3 -> CO_2 + H_2O$
   d. Respiratory system pH changes not managed by the buffers
      i. If the lungs cannot release CO_2, the shift is toward H+ HCO_3 or an excess [H+]
      ii. If too much CO_2 is released from the lungs the [H+] is below normal. When the lungs are responsible for this change it is called respiratory alkalosis or acidosis
   e. Kidneys are slowest but most efficient managers of pH changes.
      i. If the etiology is built up at [H+] because of increased production of H+ in the cells, it is known as metabolic acidosis

INSTRUCTOR'S NOTES

Osmotic pressure.

Small molecules cross much faster than do larger (NaCl vs. protein).

Acidosis.

Alkalosis.

Result of anaerobic metabolism.

ii. If the etiology is excessive loss of [H+] from the kidney or GI tract, the result is called metabolic alkalosis
iii. The kidneys can retain or release H_2CO_3 to balance [H+] and influence pH

Pathophysiology

A. Mechanism
1. Baroreceptors
a. Detection
b. Transmission
2. Response to baroreceptors discharge
a. Sympathetic nervous system
i. Cardiac effects
(a) Increased strength of contractions
(b) Increased rate of contractions
ii. Peripheral effects
(a) Arteriolar constriction
(b) Decreased container size
(c) Increased peripheral resistance
b. Adrenal
i. Cardiac
ii. Peripheral
B. Compensated shock
1. Increased strength of contractions
2. Increased rate of contractions increase in heart rate
3. Increased systemic peripheral resistance, increase in diastolic pressure
C. Uncompensated shock
1. Pump unable to maintain pressure
a. Cardiac effects
i. Decreased volume
(a) Increased strength of contractions
(b) Increased rate contractions
ii. Decreased myocardial strength
(a) Ischemia
(i) Decreased RBC oxygenation
(ii) Decreased cardiac perfusion
(aa) Coronary blood flow
(bb) Diastolic pressure
(b) Necrosis of myocardium
(i) Infarction
(ii) Increased size of infarction secondary to decreased perfusion
2. Peripheral effects
a. Peripheral vascular pooling
b. Cellular changes
i. Decreased perfusion means decreased oxygenation of tissue cells

Carotid artery.
Low pressure.
To brain.

Norepinephrine

Epinephrine.

Maintenance of systolic B/P.
Not detectable by field evaluation.
Pulse.
Narrowing of pulse pressure
Decrease in systolic and diastolic pressure.

Availability of fluid.

ii Decreased available O_2 changes aerobic metabolism to anaerobic metabolism

Assessment

A. Primary survey
   1. Airway/ventilation adequacy
   2. Circulation
      a. Pulse
         i. Rate
         ii. Character
         iii. Location
      b. Skin
         i. Color
         ii. Appearance
            (a) Pale
            (b) Cyanotic
            (c) Mottled
         iii. Temperature
            (a) Warm
            (b) Cool
         iv. Moist/dry
      c. Capillary refill
         i. Less than 2 seconds
         ii. More than 2 seconds
   3. Disability
      a. Confusion, disorientation, agitation, may result from decreased cerebral perfusion and decreased oxygenation of brain cells
      b. Mini-neurological survey

B. Secondary survey
   1. Blood pressure
   2. Head to toe

C. Monitoring
   1. Pulse
      a. Normal rate even with 10% to 15% volume deficit
      b. Detection altered by peripheral resistance
         i. Radial pulse absent: systolic pressure <80
         ii. Femoral pulse absent: systolic pressure <70
         iii. Carotid systolic pressure >60
      c. Character of pulse may reflect circulatory status
   2. Diastolic pressure
      a. Increase initially with increased peripheral resistance
      b. Coronary blood flow
      c. Normal with 15% to 20% volume deficit
   3. Systolic pressure
      a. Normal with 20% volume deficit
      b. Reflects cardiac contractility

INSTRUCTOR'S NOTES

Good perfusion.

Inadequate perfusion.

As to cause of shock.

4. Skin
   a. Color—RBC oxygenation
   b. Appearance
      i. Pale—decreased perfusion (ischemia)
      ii. Cyanotic—pooling
      iii. Mottled—combination most common
   c. Temperature
      i. Perfusion
      ii. Heat retention
5. Respiration. Acidosis produces increased [H+]. The body responds by increasing the respiratory rate to remove CO_2. Removal of CO_2 reduces [H+] $[H+] + HCO_3 -> H_2O + CO_2$

Management

A. RBC oxygenation
   1. Airway
   2. Breathing
   3. Transport
B. Tissue ischemic-sensitivity
   1. GI, liver, kidneys—45 to 60 minutes (without O_2)
   2. Muscle, skin—two to three hours
C. Pneumatic anti-shock garment
   1. Container size reduction and/or increased vascular resistance beneath device
   2. Perfusion of very ischemia-sensitive tissues
   3. Effects
      a. Capitance vessels
         i. Shifts pooled blood
         ii. Increased upper body blood
         iii. Part of blood volume may be translocated to upper portion of body
         iv. Increased pressure of blood returning to the heart
      b. Peripheral resistance increased
         i. Decreased blood flow to ischemic resistance tissues
         ii. No change in peripheral resistance of ishemic sensitive tissues
      c. Diaphragmatic excursion
         i. 50% movement reduction
         ii. Increased intrathoracic pressure
         iii. $Pa.O_2$,Ph,$PaCO_2$ not compromised
      d. Tissue pressure—Indirectly transmitted through the skin subcutaneously, and muscle tissue surrounding muscle
      e. Rigid external stabilization
         i. Pelvic fracture reduction/stabilization
         ii. Femur stabilization
   4. Clinical consequences
      a. Increased upper body blood volume

Ischemic

Length of time an organ can remain viable.

PASG

At time of printing the exact mechanisms of action are under investigation.

Theoretical.

Selective.

Muscles and skin of legs.

Deep.

Traction splint superior without shock.

i. Increased blood pressure
(a) Increased cardiac output
(b) Distended neck veins
ii. Increased pulmonary blood volume
(a) Increased cardiac output with intra-pulmonary pressure
iii. Increased lower body peripheral resistance
(a) Increased flow to upper body organs
(b) Decreased perfusion to lower body organs if systolic pressure is less than 80 mm Hg
iv. Increased tissue pressure
(a) Reduction of intra-abdominal hemorrhage
(b) Reduction of pelvic fracture hemorrhage
(c) Reduction of lower abdomen retroperitoneal hemorrhage
v. Decreased diaphragmatic excursion
(a) Observation for ventilation and oxygenation inadequacy
(b) Increased intrathoracic pressure
(i) Increased cardiac output with CPR
(ii) Increased cardiac output with respiration

5. Clinical applications
a. Shock resuscitation
i. Increased blood return
ii. Increased vascular resistance
iii Increased blood pressure
iv. Decreased heart rate
v. Increased perfusion of organs in upper half of body
b. Hemorrhage control
i. Intra-abdominal
(a) Aorta
(b) Liver, spleen
(c) Retroperitoneal
(d) Pelvic
ii. Lower extremities
(a) Skin, muscle
(b) Femur
c. Fracture stabilization
i. Rigid external immobilization
ii. Femur
iii. Pelvis
d. Cardiac arrest
i. Increased cardiac output
(a) Increased blood return
(b) Increased intrathoracic pressure
(c) Increased pulmonary blood volume
ii. Increased carotid blood flow
(a) Increased cardiac output

Lower extremities, abdomen.

Controversial at time of printing.

2x.

(b) Selective increased peripheral resistance
iii. Increased cerebral blood flow
(a) 3% to 10%
(b) Increased but still deficient

D. Fluid replacement
1. Whole blood
2. Crystalloid
a. Ringer's lactate
i. Isotonic
ii. Buffer when metabolized
b. normal saline
i. Isotonic
ii. No buffer
c. Volume expansion
i. Immediately effective
ii. 2/3 lost to intraatrial space in one hour
d. 2 to 3 liters maximum
3. Glucose
a. Immediate volume expansion
b. Rapid loss
c. Resultant free H_2O increase
4. Plasma
a. Volume expansion not presently a prehospital fluid
b. Storage and cost reduce prehospital usefulness
5. Dextran
a. Volume expansion
b. Type and cross match abnormality
c. Bleeding abnormalities

E. Rate of replacement
1. Monitoring parameters
a. Pulse
b. Blood pressure
c. Skin—color, temperature, capillary refill time

F. Routes of fluid replacement
1. Rational
a. Replacement as rapid as possible may be necessary
b. Rate of administration determined by
i. Length of catheter
ii. Internal diameter of catheter
(a) Small increase in radius equals large increase in area
(b) Area inside of lumen determines the rate of flow
(c) Maximum rate
(d) 22 gauge preferred for medical patient
(e) 16–14 gauge preferred for trauma patient
iii. Size of vein has no relationship to flow

Most desirable because of O_2 carrying; however, is not a fluid which is available for prehospital use.

Because of rapid loss of crystalloid from the cardiovascular space the patient should be transported to the hospital as rapidly as possible.

5 to 15 min. as glucose metabolized.

Not a prehospital technique

Inversely.

Directly.

Are dependent upon size (gauge).

iv. Central line has no prehospital use

2. Peripheral
   a. Advantages
      i. Rapid identification
      ii. Minimal equipment
      iii. Rapid insertion
      iv. Can be accomplished while other things going on
      v. Maintenance good
      vi. Easily accessible
   b. Disadvantages
      i. In severe volume depletion is difficult to locate vessels
      ii. Collapse and roll easily

G. Steps in shock management for severely injured patients
   1. Extrication
   2. Pneumatic antishock garment application
   3. Stabilization
   4. Load for transportation
   5. Administration of IV fluids (en route to hospital)
      a. Ambulance en route to hospital
         i. Preliminary steps for IV
            (a) Tourniquet
            (b) Vein identified
            (c) Tape torn
            (d) IV set up
            (e) Skin prepped
            (f) Ambulance stopped
            (g) Insert catheter
            (h) Needle taped down
            (i) Ambulance en route again
            (j) Fluid rate adjusted

INSTRUCTOR'S NOTES

Time required to start IV before rolling ambulance toward hospital includes setup time for the administration set, tearing the tape, etc. If all of this is accomplished while the ambulance is en route & stopped only long enough to insert the needle the patient will arrive at the hospital several minutes faster.